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ABSTRACT

In light of conflicting and limited results in the assessment of the effects of text-forming structures, a study investigated the effects of specific microlevel and macrolevel text-forming elements on readers' comprehension of selected passages of scientific technical prose. More specifically, the study examined the individual and combined effects of intersentential cohesive conjunctions, reference, lexical cohesion, and rhetorical predicates on college freshmen's comprehension (free recall and reading rate) of these passages. Subjects for the experiment were 160 students in freshman composition classes. Each subject read one of 16 versions of texts dealing with fairly technical scientific topics. During the 12 data gathering sessions, subjects were asked to read the passages at their normal reading rates, record their reading times, and write as much as they could recall of the passage. Analyses of the data revealed no systematic effects of intersentential cohesive conjunctions, reference, lexical cohesion, and rhetorical predicates on reading rate and written free recall. These findings appear to support the argument that surface level linking structures are not causes but symptoms or reflections of the underlying coherence of connectivity of text-knowledge and world-knowledge. (RL)

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The Effects of Selected Text-Forming Structures on College Freshmen's Comprehension of Expository Prose

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The present study represents an attempt to test some of the strong claims about the text-forming effects of micro-level cohesive elements on discourse. Claims for these structures have been made routinely by rhetoricians (Crews, 1974; Daiker, Kerek, & Morenberg, 1979; Graham, 1977; Guth, 1965; Hairston, 1974; Legget, Mead & Charvat, 1974; Winterowd, 1975). More recently theoretically based claims have been made by a number of linguists (Halliday & Hasan, 1976; Hasan, 1968; Lyons, 1977). Additionally, the study tests counter claims which argue that the effects of these micro-level cohesive elements are less important than those macro-level structures previously described as rhetorical predicates (Meyer, 1975, 1979; Meyer, Brandt, & Bluth, 1978; Meyer, Freedle, & Walker, 1977).

Relations Between Textual Cohesion and Discourse Coherence: Previous Work

Cohesion/Coherence

Theoretical considerations of cohesion/coherence. Those linguistic features which have been given serious consideration as text-forming devices or cohesive elements have been most thoroughly discussed by Halliday and Hasan (1976). They define cohesion as a semantic relationship between two elements in a text, a presupposing element and a presupposed element, a relationship achieved by reference, substitution, ellipsis, conjunction, and lexical

The relationship between these cohesive elements and overall discourse coherence has been differently posed. A number of writers have employed a bottom-up processing model (Becker, 1965; Cummings, Herum, & Lybbert, 1971; Hairston, 1974; Holloway, 1981; Lyons, 1977; Nelson & Stalter, 1978; Pickering, 1978; Walmsley, 1977; Winterowd, 1970) which presumes overall discourse coherence as the result of the interaction of a set of micro-level (local) features of a text. Others have employed a top-down processing model (Crothers, 1979; de Beaugrande, 1978, 1980; Kintsch & van Dijk, 1978; Morgan, 1978, 1980; Thorndyke, 1977; Turner & Greene, 1977; van Dijk, 1977, 1977a; Warren, Nicholas, & Trabasso, 1979) in which the effects of so-called cohesive structures are minimal, inasmuch as they are modified and integrated into the text's larger, macro-structures, which are in turn modified by the reader's prior knowledge of the world, including knowledge about the structure and organization of texts.

The extent to which micro-level cohesive devices contribute to local and global discourse coherence can only be hypothesized by theory. More accurate predictions of the effects of conjunction, reference, substitution, ellipsis, and lexical cohesion can result only after they have been tested experimentally.

Experimental studies of cohesion/coherence. There have been few experimental investigations of the relationship between the micro-level cohesive devices under consideration in the present study (conjunction, reference, and lexical cohesion) and factors of local

and global discourse coherence. Of the few that have been conducted, some (Carpenter & Just, 1977; Clark, 1977; Drum, 1979; Jarvella, 1973; Moberly, 1978; Pearson, 1974-75; Stone, 1979; Williams, Taylor, & Ganger, 1980) conclude by asserting a strong relationship. Others (Fishman, 1977; Hagerup-Neilson, 1977; Irwin, 1978; Kintsch, Kozminsky, Streby, McKoon, & Keenan, 1975; Vipond, 1980) conclude that there is only a weak relationship.

Theoretical and experimental studies of rhetorical predicates. A second aspect of the present study deals with another class of structures, rhetorical predicates (RPs), considered text-forming. RPs are statements that specify the structural relations of ideas that constitute the content of a text (cf. Grimes, 1975; Meyer, 1975). They may also be viewed as signals that explicitly illustrate a writer's perspective on the content of a text. RPs are macro-level text-forming elements presumed to assist readers in testing hypotheses about a text's overall structure.

Four types of RPs have been investigated (Meyer et al., 1975, 1977, 1978): adversative, covariance, response, and attribution with mixed results. In one study (Meyer, 1975), RPs did not facilitate recall as measured by the number of propositions recalled; in still another study (Meyer et al., 1978) the effects of RPs were mixed, facilitating recall of one passage but not another, with facilitative effects shown to be greatest for low and average ability readers. Finally, Horowitz, Piché, and Samuels (1980) examined the effects of each of the four types of RPs on written free recall for ninth graders

and college freshmen. Results indicated that there was no significant effect on reading comprehension by type of RP, even though the type of RP used to organize a text did affect reading time for college freshmen. More recently, Meyer (1979) has suggested that types of signaling, including RPs, do help readers with poor comprehension skills. These structures may also help better readers comprehend poorly organized texts. Clearly, more basic research is needed to integrate these variables into a more complete processing model.

Considerations of the Present Study

In light of these conflicting and limited results in the assessment of the effects of text-forming structures, there is a need for study of a wider range of structures, micro- and macro-level, on a wider range of populations. Studies need to test the interactive effects of these text features in order to develop a greater understanding of the relative importance of each and to ensure greater ecological validity; there is a need for studies that employ longer texts, texts that resemble those actually read by high school and college students.

It is in this context that the present study investigates the effects of specific micro- and macro-level text-forming elements on readers' comprehension of selected passages of scientific technical prose. More specifically, the study examines the individual and combined effects of intersentential cohesive conjunctions, reference (vis-à-vis lexical cohesion), and Response RPs on college freshmen's comprehension (as measured by written free recall and reading rate) of these passages.

Methods

Subjects

Subjects for the experiment were 160 students enrolled in 12 sections of the first quarter of a freshman composition sequence in the Department of English at the University of Minnesota.

Stimulus Materials

Each subject read 1 of 16 text versions. These texts dealt with two topics: the controversy over the evolutionary significance of Neanderthal man (Trinkaus & Howells, 1979) and the anthropological significance of a Pre-Neolithic farming village recently unearthed in southeastern Asia (Moore, 1979). Each of the texts was a slightly modified version of a much longer text that had appeared in Scientific American (1979). In effect, they were examples of fairly long (745-882 words), fairly technical, scientific exposition.

Results of a pilot study indicated that although a cohesive conjunction (CC) high-reference (REF) high treatment combination facilitated reading rate, the CC high condition, as well as the CC-REF high treatment combination, exerted statistically significant negative effects on written free recall, which is likely to be a more important measure than reading rate.

In order to avoid the negative effects of an extremely high frequency of CCs, the experimental passages employed in the final study included a more moderate level of CCs. In the CC high condition the passage versions contained 19 CCs, such as however, therefore,

that is, and on the other hand, that did not occur in the CC low condition. This number was obtained by finding the mean number of such CCs appearing in 10 randomly selected excerpts from 10 randomly selected articles appearing in recent issues of Scientific American from which the original versions of the experimental passages appeared. Because the CCs served as intersentential connectors, sentence structure remained constant across all eight versions of each of the two basic texts. Sentence length was, of course, increased by the number of words that composed each of the 19 CCs.

The 16 passage versions employed in the major study varied along a third dimension. Specifically, 8 of the 16 passage versions included 25 personal pronouns or demonstratives that did not appear in the other 8 passage versions. In the remaining 8 passage versions those 25 nominal elements occurred as repetitions of nouns, synonyms, or near synonyms. These two treatment conditions are labeled reference (REF) high and REF low, respectively.

Finally, passage versions varied along a fourth dimension. Half of the 16 passage versions contained explicit statements (response rhetorical predicates) that indicated to readers that a problem-solution relationship existed among the ideas in those passage versions. This treatment condition is labeled the response rhetorical predicate present (RPP) condition. The remaining 8 versions contained no RRP. This treatment condition is labeled the RRP absent condition.

There were several reasons for the use of an RRP in the experimental passages. First, a Meyer (1975) analysis of the content of each of the passages revealed a problem-solution top-level structure. There were, of course, other types of rhetorical structures (adversative, covariance, additive) embedded in the passages at various positions. Second, as Jordan (1980) argues, problem-solution top-level structures are endemic to scientific-technical prose.

To assess the readability of each of the 16 passage versions, the Fry Readability Graph (Fry, 1977) was used. Table 1 indicates that the readability of these versions of these passages was substantially higher than grade 13, the grade level of all of the subjects in

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Insert Table 1 about here

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this study. Further analysis indicates that the readability of 24 randomly selected 100-word excerpts taken from the 8 Neanderthal passage versions had a mean readability of grade 16 while 24 randomly selected 100-word excerpts taken from the 8 Pre-Neolithic Farming passage versions had a mean readability of grade 17+. While Neanderthal excerpts had a mean of 6.98 sentences, Pre-Neolithic Farming excerpts had a mean of 7.42 sentences. Further, the Neanderthal passages had a mean of 179.67 syllables while Pre-Neolithic Farming passages had a mean of 183.42 syllables.

The selection of passages like these for study rests on two assumptions. The first assumption is that texts like these (fairly

difficult technical, scientific prose) have a kind of face ecological validity, representing precisely the kind of texts which college and university students encounter in their initial coursework, coupled with a demand that they be read with maximum comprehension. Secondly, there is some speculation that textual variables similar to those under consideration here exert little effect on younger or older skilled readers reading relatively easy texts (Drum, 1979; Hagerup-Neilson, 1977), warranting an assumption that they are most likely to exert an effect when they are entailed in longer, technically more difficult passages.

Procedures

Through the use of a table of random numbers (Winter, 1971, pp. 881-882), all 160 subjects were randomly assigned to 1 of 16 experimental treatment conditions, which are summarized in Table 1.

All of the data for this study were gathered during the first three weeks of November in 1980. During each of the 12 data gathering sessions, each subject received a test packet containing the following items: (1) a consent form to be retained by the subjects; (2) a consent form to be returned to the investigator; (3) a brief questionnaire; (4) a set of directions; (5) a passage to read; (6) four pages of lined composition paper.

These test packets were distributed to subjects as they entered their regular composition classrooms. Subjects were told to read and sign both consent forms and to keep one of them. They were told not to look at any pages that followed the forms. After subjects had

read and signed the consent forms, they were asked to complete a brief questionnaire that asked them to indicate their age, academic status, and sex.

Directions were read aloud to subjects, asking them to read the passage that followed and to record their reading times to the nearest second. After doing that they were to recall as much of the passage as possible. Their free recalls were to be written on lined composition paper provided. The directions emphasized that subjects were to read at their normal rates and for the purpose of recalling what they had read.

Outcome Measures

The written free recall protocols were subjected to an analysis of the number of idea units recalled. The rules for counting idea units were essentially those described and employed by Meyer (1975). Specifically, in the current study, each of the texts was segmented into propositions in the order in which they occurred in the text. Each of those prepositions was, in turn, divided into its predicate and its arguments. Each argument was then given a label that indicated its specific semantic relationship (role) with the predicate. Each experimental subject was given credit (one point) for recalling an idea unit if his/her written free recall protocol contained an exact copy or a recognizable paraphrase of that unit. Each subject was given an additional point for each recalled argument if it had the same role (semantic relationship) with respect to its predicate that it held in the stimulus text.

Two graduate student coders conducted the scoring independently. Each scored 80 recall protocols which had been randomly assigned. Additionally, the two coders scored 30 randomly assigned recall protocols in common in order to estimate intercoder reliabilities. The Pearson Product-Moment correlation coefficient between coders was .90 for the number of idea units counted.

A net recall score for each subject was submitted to statistical analysis. That score was derived by first counting the total number of idea units and role relations recalled by a subject. Idea units for CCs and the RRP that were recalled were subtracted from the total recall score to yield a net recall score. This procedure was followed because Meyer (1977) has argued convincingly that CCs and RRPs are signals. As such, they do not add new content; rather, they simply make more explicit the information that is already contained in the passage.

Results

Reading Rate

The first dependent measure to be submitted to a 2 x 2 x 2 x 2 random factor analysis of variance (ANOVA) was reading rate. This analysis, as well as all others, was conducted with an a priori .05 level of significance. The ANOVA results for reading rate, which are summarized in Table 2, indicated that there were no significant main

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Insert Table 2 about here

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effects for topic, CC, REF, or RRP. However, the main effect for RRP approached significance ($p = .099$). The mean reading rate for subjects who had read passage versions with a RPP was 156.11 words per minute while the mean reading rate for those who had read passage versions without a RRP was 165.99. Across all passage versions the mean reading rate was 161.05 words per minute. Means for all of the main effects for reading rate appear in Table 3.

Insert Table 3 about here

None of the two-way interactions for reading rate approached statistical significance as Table 2 indicates.

While three of the three-way interactions for reading rate did not approach significance, the topic x CC x REF interaction was significant ($p = .025$). The means for that interaction appear in Table 4.

Insert Table 4 about here

A graphical inspection of that interaction, which appears in Figure 1, indicates that reading rate for subjects who had read the Neanderthals passage versions was highest if those versions had

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Insert Figure 1 about here

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contained high levels of CC and REF. Conversely, subjects who had read similar versions of the Pre-Neolithic Farming passage, versions

with high levels of CC and REF, had the lowest reading rates. Reading rate was further depressed for subjects who had read the Neanderthal passage versions with high levels of CC and low levels of REF. In the Pre-Neolithic Farming passage versions the same condition, high levels of CC and low levels of REF, resulted in the highest reading rate. For subjects who had read passage versions with low levels of CC, the effects of REF were less extreme; they were also in the opposite direction.

The four-way interaction for reading rate, like the two-way interactions described earlier, did not approach statistical significance. The ANOVA results for that interaction appear in Table 2.

Written Free Recall

A 2 x 2 x 2 x 2 ANOVA revealed that topic was highly significant ($p = .001$). That is, subjects who had read the Neanderthal passage versions recalled significantly more idea units than subjects who had read the Pre-Neolithic Farming passage versions ($\bar{X}_N = 76.3125$, $\bar{X}_P = 58.4625$). As a result of this difference, two separate ANOVAs for written free recall were performed, one for each topic.

Written Free Recall for Neanderthal Passage Versions

The ANOVA results for free recall of Neanderthal passage versions, which appear in Table 5 indicate that none of the main effects

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Insert Table 5 about here

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approached the a priori level of statistical significance. The means for those effects appear in Table 6. Similarly, none of the two-way or three-way interactions were significant.

Insert Table 6 about here

Written Free Recall for Pre-Neolithic Farming Passage Versions

While the results for written free recall of Pre-Neolithic Farming passage versions indicate that there were no significant main effects for CC or REF, the main effect for RRP was statistically significant ($p = .042$). As Table 6 indicates, subjects who had read the Pre-Neolithic Farming passage version without a RRP recalled a mean of 64.600 idea units while those who had read versions with a RRP recalled 52.325 units.

The Relationship Between Written Free Recall and Reading Rate

To test the strength of the relationship between the rate at which subjects read and the number of idea units they recalled, three Pearson Product-Moment correlations were calculated. To calculate the first correlation coefficient, the reading rate and written free recall score for each of the entire sample of 160 subjects were included. Results indicated that there was almost no relationship between a subject's reading rate and written free recall score ($r = .0012$, $p = .988$).

Since an earlier analysis had revealed a strong effect for topic, two additional correlation coefficients were computed, one for each of the two passage topics. The Pearson Product-Moment correlation for the 80 subjects who had read the Neanderthal passage versions indicated once again that there was almost no relationship between reading rate and the number of idea units recalled ($r = -.0164$, $p = .885$). The relationship between reading rate and the number of idea units recalled was similarly weak for subjects who had read the Pre-Neolithic Farming passage versions ($r = -.0076$, $p = .946$).

Discussion

The effects of intersentential cohesive conjunctions on reading rate and written free recall. As a main effect the presence of intersentential cohesive conjunctions (CC) did little to increase reading rate or written free recall. The absence of any main effect raises questions about the psychological reality of the relationship between quantitative differences in textual cohesion due to CC and quantitative differences in discourse coherence (Crothers, 1979; Turner & Greene, 1977). Rhetoricians' advice to writers that they use intersentential cohesive conjunctions (transition words) to produce more coherent expository writing (Crews, 1974; Daiker et al., 1979, Graham, 1977; Guth, 1965; Leggett et al., 1974; Winterowd, 1975) may need qualification. While these rhetorical claims seem to have intuitive credibility, experimental results of previous studies (Hagerup-Neilson, 1977; Irwin, 1978; Vipond, 1980), as well as the present study, suggest that such claims have little empirical support.

The effects of reference on reading rate and written free recall. There was no main effect for reference (REF) for either of the two dependent measures. However, as was previously described, REF was included in one significant interaction, topic x CC x REF, for reading rate. Specifically, the Pre-Neolithic Farming passage versions were read more rapidly when they included a low level of REF (or high level of LC) combined with a high level of CC. Since REF was so highly bound to context, previous claims about the facilitative effects of recurrences of items, or lexical cohesion (de Beaugrande, 1980; Kintsch, 1974), may need further examination. More specifically, the relationship between ease of processing versus depth of processing information on texts may need to be clarified through further experimental studies. Results of the current study do not support findings (Carpenter & Just, 1977; Drum, 1979) that searching for less explicit anaphoric referents is a time-consuming inferential activity. Nor do the results of the current study support Clark's (1977) finding that this type of inferential activity requires additional processing (de Beaugrande, 1980; Drum, 1979) that results in greater comprehension.

The general absence of effect for these so-called cohesive text structures tends to support top-down models of discourse processing. From such a model, it is assumed that a reader with normal inferencing skills is able to form an explicit text base through the interaction of a more-or-less implicit text base and various types of prior knowledge. Other researchers make an even stronger argument (de Beaugrande, 1981a; Morgan, 1978, 1980; Morgan & Sellner, 1980;

Webber, 1980), concluding that Halliday and Hasan's (1976) micro-level cohesive devices do not enhance discourse coherence, but rather that coherent discourse makes these devices possible. What is most important in the formation of a coherent discourse is not the explicitness of micro-level textual information but the "underlying connectivity of text-knowledge and world-knowledge" (de Beaugrande, 1980, p. 132).

The effects of response rhetorical predicates on reading rate and written free recall. While the main effect for response rhetorical predicates (RRPs) on reading rate was not significant ($F_{df=1,144} = 2.754$, $p = .099$), the presence of an RRP did result in a decrease in overall reading rate. More importantly, the presence of a RRP exerted a negative effect on written free recall, an effect which was significant for the Pre-Neolithic Farming passage versions. Difficult to explain, it may be that the effects of RRPs, as well as those of other types of rhetorical predicates, are so highly context bound that they cannot be predicted across different text types or topics. Indeed, an examination of the results of previous studies (Meyer, 1975, 1977; Meyer et al., 1977, 1978) suggests that these effects cannot be consistently predicted.

General considerations of the effects of micro-level and macro-level text-forming structures. The present study reveals no systematic effects of intersentential cohesive conjunctions, reference, lexical cohesion, and response rhetorical predicates on reading rate and written free recall. These findings appear to support those writers

previously cited who argue that surface level linking structures are not cause, but are rather a symptom or reflection of the underlying coherence or connectivity of text-knowledge and world-knowledge. When the underlying propositional content of a text is coherent, readers may process discourse without any benefit following from explicit cohesive connections in the surface structure. The possibility of a reader's achieving discourse coherence is increased if his/her activated, macro-level frames or schemata are appropriate for the text and if they are adequately developed to process the text. That is, it must be possible for the reader to readily integrate new textual information into existing knowledge structures. Unfortunately, the textual representation of these conjunctive schemata remain elusive.

It is clear that much experimental work remains to be done in mapping the effects of micro-level and macro-level text-forming structures like those under consideration in the present study. Approaching that work we will be well advised to consider Fowler's (1977) observation that:

> . . . the construction of an explanatorily adequate text grammar for a specified example of one type of discourse [is] a project of unattainable magnitude for the imaginable future, if the criterion is to be observed that a text grammar reflects readers' textual competence. We simply know too little about linguistic structure, the psychology of the reading activity, etc. . . . The median level of adequacy might be the appropriate aim--and that level of adequacy only for some chosen aspect of text structure.

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Table 1

Summary of Passage Versions

Topic	Cohesive Conjunctions	Reference	Rhetorical Predicate	Number of words	Number of Sentences	Readability
Neanderthals	Low	Low	Absent	787	59	16
Neanderthals	Low	Low	Present	843	63	17+
Neanderthals	Low	High	Absent	745	59	15
Neanderthals	Low	High	Present	792	63	16
Neanderthals	High	Low	Absent	826	59	16
Neanderthals	High	Low	Present	882	63	17+
Neanderthals	High	High	Absent	766	59	16
Neanderthals	High	High	Present	832	63	13
Pre-Neolithic Farming	Low	Low	Absent	764	63	17+
Pre-Neolithic Farming	Low	Low	Present	832	64	17+
Pre-Neolithic Farming	Low	High	Absent	749	63	15
Pre-Neolithic Farming	Low	High	Present	784	64	17+
Pre-Neolithic Farming	High	Low	Absent	797	63	17+
Pre-Neolithic Farming	High	Low	Present	849	64	16
Pre-Neolithic Farming	High	High	Absent	748	63	17+
Pre-Neolithic Farming	High	High	Present	808	64	17+

Table 2

Summary of ANOVA for Reading Rates

Source of Variation	df	F-Values
Topic (T)	1	.186
CC	1	.096
REF	1	.013
RRP	1	2.754
T x CC	1	.079
T x REF	1	.424
T x RRP	1	1.048
CC x REF	1	.805
CC x RRP	1	.000
REF x RRP	1	1.039
T x CC x REF	1	5.132*
T x CC x RRP	1	.837
T x REF x RRP	1	.903
CC x REF x RRP	1	.613
T x CC x REF x RRP	1	.128

*p<.05

Table 3

Means for Main Effects on Reading Rate

Variable	Means
Topic	
Neanderthals	162.3308
Pre-Neolithic Farming	159.7673
CC	
Low	160.1285
High	161.9695
REF	
Low	160.7060
High	161.3920
RRP	
Absent	165.9825
Present	156.1112
Total (n= 160)	161.0490

Table 4

Means for the Significant Topic x CC x REF Interaction

	Neanderthals		Pre-Neolithic Farming	
	CC Low	CC High	CC Low	CC High
REF High	158.7830	170.4380	167.4985	148.8485
REF Low	162.3640	157.7380	151.8685	170.8535

Table 5

Summary of ANOVAs for Free Recall

Source of Variation	df	F-Values	
		Neanderthals	Pre-Neolithic Farming
CC	1	.012	.610
REF	1	.890	.135
RRP	1	.026	4.296*
CC x REF	1	1.156	.027
CC x RRP	1	.204	.462
REF x RRP	1	.007	.009
CC x REF x RRP	1	.341	1.159

p<.05

Table 6

Means for Main Effects on Free Recall

Variable	Means	
	Neanderthals	Pre-Neolithic Farming
CC		
Low	76.6250	56.1500
High	76.0000	60.7750
REF		
Low	79.0000	57.3750
High	73.6250	59.5500
RRP		
Absent	76.8500	64.6000
Present	75.7750	52.3250
Total	76.3125 (n = 80)	58.4625 (n = 80)

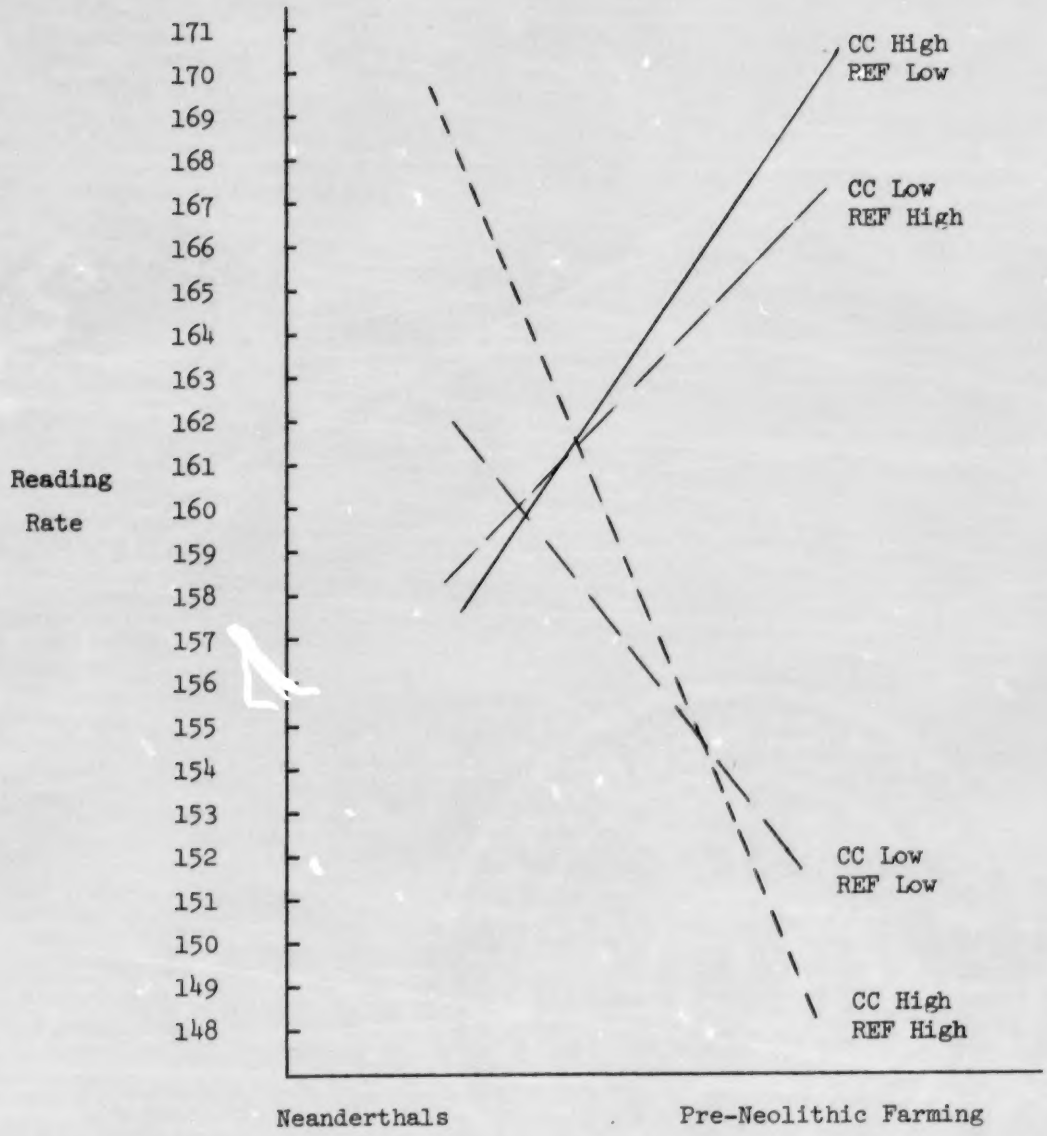

Figure 1

Significant Interaction Between Topic,
CC, and REF on Reading Rate